

CAREER: Polymer Langmuir Monolayers: Boundaries, Dynamics and Thermodynamics

Elizabeth K. Mann, Kent State University, DMR-9984304

The ability of polydimethylsiloxane (PDMS) to coat surfaces to modify their properties leads to the utilization of PDMS and its derivatives in everything from sensors to antifoaming agents. However, little is known about structural mechanisms for macromolecular packing and dynamics in ultrathin films, in spite of much speculation.

We use deuterium nuclear magnetic resonance (DNMR) to probe for methyl side-group ordering induced by the surface, which also gives us insight into backbone conformation. Anopore membranes provided $\sim 2 \text{ m}^2$ of well-oriented surface for PDMS film deposition, ample to obtain good DNMR signals down to a fraction of a monolayer. Spectra (fig. 2) below the glass transition for the polymer, compared with those at room temperature, strongly suggest that the polymer forms an extended caterpillars structure, rather than the helical structure often suggested.

This work also demonstrates that DNMR can characterize films with as little as 0.2 nm average thickness.

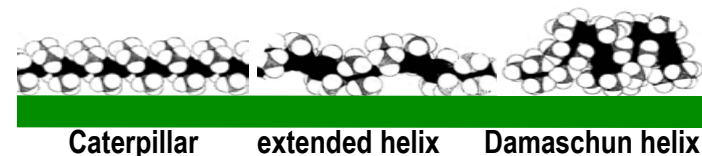


Fig. 1. Suggested conformations of PDMS at a surface.

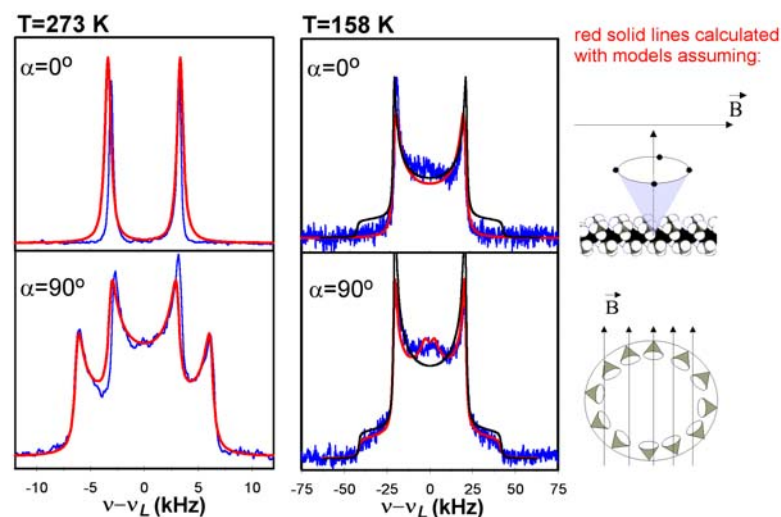


Fig. 2. DNMR spectra for PDMS, above and below the surface glass transition temperature. Films are deposited in cylindrical pores: in the top spectra, the magnetic field is parallel to the pores and in the bottom spectra perpendicular to the pores. Red lines assume the caterpillar structure while black lines assume an isotropic distribution of methyl groups, as expected for a helical structure.

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Students:

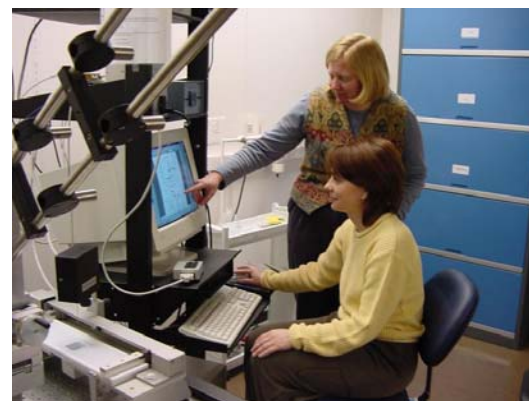
- Undergrads: Violeta Beleva, James Davis.
- 1 MS student: Edgar E. Kooijman; (MS, 2001; present position: doctoral student in "Biochemistry of Membranes", Utrecht University, the Netherlands).
- 1 MA student: James Dillon (teacher, Mansfield High School)
- 2 PhD students: Lu Zou, Svetlana V. Primak (Ph.D., 2002; Present position: postdoctoral associate, Pacific Northwest National Laboratory, Richland, WA).

Course development:

Introduced peer instruction and JITT to 70 students in General College Physics ("I use to be afraid of physics...now I am stimulated to think of how physics is involved in every aspect of my daily living," wrote a female student).

Outreach Activities (participation):

- 15th annual Women in Science Career Workshop, Cuyahoga Community College.
- The Young Women's Summer Institute, Kent State Univ.



Svetlana Primak (front) with the Brewster angle microscope which she helped optimize, with Edgar Kooijman, to look at ultra-thin polymer layers.



From Workshop/demo: « the physics of soap films ».